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Multi-responsive Semi-Interpetrating Network Hydrogels

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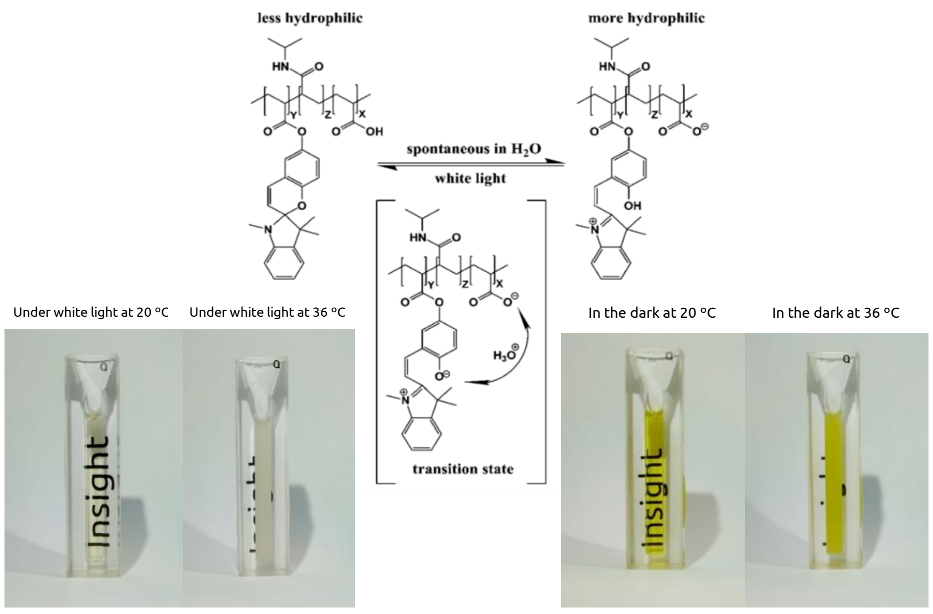
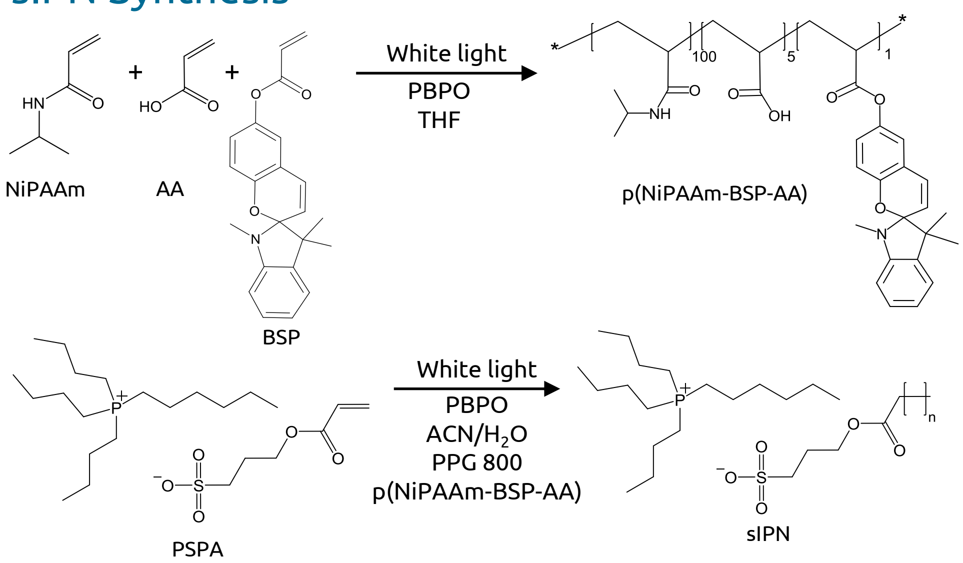
Introduction

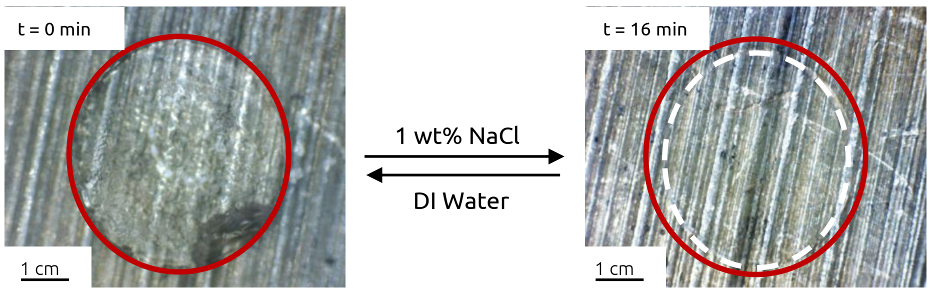
Semi-interpenetrating networks (sIPNs) are a type of polymer networks in which one polymer is crosslinked in the presence of a linear polymer solution. The materials used in this case are the poly(ionic liquid) (PIL), tributylhexyl phosphonium 3-sulfopropyl acrylate (PSPA) as the crosslinked matrix while the linear polymer is a poly(N-isopropylacrylamide-*co*-spiropyran-*co*-acrylic acid) p(NiPAAm-BSP-AA) copolymer, which is both thermo- and photo-responsive. The research described herein focuses on determining the influence of temperature, white light and salt concentration on the are of the sIPN hydrogels swollen in deionized water (DI water). The area shrinkage was calculated using the following formula: $\%s = (A_i - A_f)/A_i \times 100$, where A_i is the initial area of the swollen hydrogel and A_f is the final area of the hydrogel after the application of the stimulus.



sIPN Synthesis

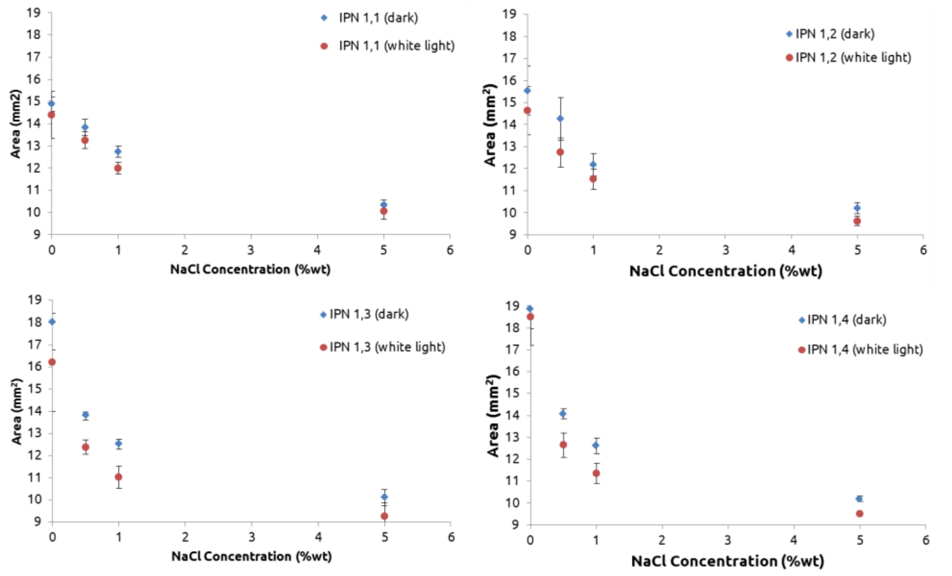


Salt Concentration Induced Shrinking



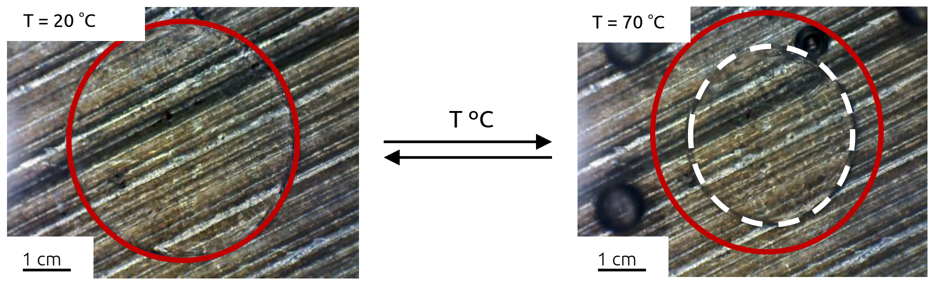
The crosslinked PIL hydrogel shrank by ~16% in area when its hydration medium was changed from DI water to 1 wt% NaCl solution. The salt concentration induced shrinking is a reversible process. Changing the hydration medium back to DI water causes the gel to return to its initial size.

White-light Induced Shrinking

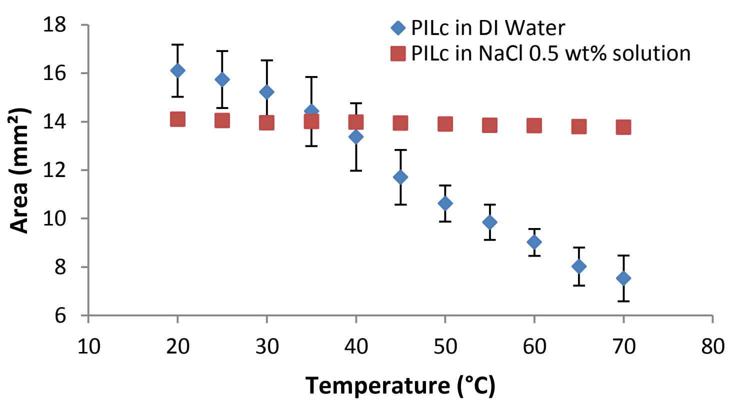


The sIPN hydrogels were hydrated in deionized water and NaCl solutions of different concentrations, 0.5%, 1% and 5% (wt%), respectively, followed by exposure to an illumination level of 200 kLux. The resulting shrinking in area is shown above.

Temperature Induced Shrinking



The increase in temperature from 20 °C to 70 °C causes the crosslinked PIL hydrogel to shrink by ~53% in area. As in the case of salt concentration, the temperature induced shrinking is a reversible, repeatable process.



The presence of a chaotropic salt in the hydration solution of the crosslinked hydrogels inhibits the temperature-induced shrinking. This behavior is exemplified on the crosslinked PIL.

Conclusions

A functional polymer has been synthesized by copolymerizing NiPAAm with BSP and AA. This copolymer has been embedded into a PSPA matrix, creating a series of sIPNs that exhibited various degrees of shrinking when exposed to white light, salt concentration, and an increase in temperature, respectively.

Acknowledgements

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